OCR
Oxford Cambridge and RSA

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Wednesday 15 June 2016 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A/ADDITIONAL SCIENCE A

A172/01 Modules C4 C5 C6 (Foundation Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

* A 1 7 2 0 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with a pencil (✎).
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.
- A list of qualitative tests for ions is printed on page **2**.
- The Periodic Table is printed on the back page.

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Qualitative analysis

Tests for ions with a positive charge

Ion	Test	Observation
calcium Ca^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu^{2+}	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe^{2+}	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe^{3+}	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

Tests for ions with a negative charge

Ion	Test	Observation
carbonate CO_3^{2-}	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride Cl^-	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide Br^-	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide I^-	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate SO_4^{2-}	add dilute acid, then add barium chloride or barium nitrate	a white precipitate forms

Answer **all** the questions.

1 In 1864, a chemist called John Newlands had an idea of arranging the elements in order, depending on their chemical properties.

He called his idea the 'Law of Octaves'.

(a) Newlands put elements with similar properties together.

He put lithium, sodium and potassium together.

Give **two** ways that the properties of lithium, sodium and potassium are similar.

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..... **[2]**

(b) The table shows Newlands' arrangement of some of the elements.

He put elements with similar properties into the same row of his table.

Row			
1	H	F	C*l*
2	Li	Na	K
3	G*l*	Mg	Ca
4	Bo	A*l*	Cr
5	C	Si	Ti
6	N	P	Mn
7	O	S	Fe

Newlands based the order of the elements on their relative atomic masses.

(i) Find the relative atomic masses for the elements in Row 1 of Newlands' table.
Use the **Periodic Table** on page 20 to help you.

Relative atomic masses H ..... F ..... C*l* ..... **[1]**

(ii) Use your answer to describe the trend in relative atomic masses across Row 1.

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..... **[1]**

(iii) The Periodic Table that is used today was developed after Newlands' table.

In **Newlands' table**, the elements H, F and C*l* are all together in Row 1.

In the **Periodic Table**, these elements are not all together in the same group.

Where are these elements placed in the Periodic Table?

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..... **[2]**

(iv) One group of elements on the Periodic Table is completely missing from Newlands' table.

Which group is completely missing?
Use the Periodic Table to help you.

Put a (ring) around the correct answer.

Group 4 **Group 5** **Group 6** **Group 0** **[1]**

(v) What is the most likely reason for Newlands missing these elements out of his table?

Put a tick (✓) in the box next to the best answer.

He only wanted to classify a few elements. ☐

These elements were not discovered at the time. ☐

He did not know the symbols for these elements. ☐

These elements do not have a relative atomic mass. ☐

[1]

(vi) The symbols that Newlands used for some of the elements are different to those used today.

Complete the table to show the symbols used today for elements G*l* and Bo.
Use the Periodic Table to help you.

Newlands' symbol	Relative atomic mass	Symbol used today
G*l*	9	
Bo	11	

[2]

(c) Newlands' arrangement was based on putting the elements in order of their relative atomic masses.

What decides the order of elements in the Periodic Table today?

Put a tick (✓) in the box next to the correct answer.

the number of neutrons in the atom	☐
the proton number	☐
the type of bonds the elements form	☐
the relative atomic mass	☐

[1]

[Total: 11]

2 Joe collects some samples of three minerals, **A**, **B** and **C**.

He thinks the minerals contain compounds of Group 1 elements.

He looks up the flame colours for some Group 1 elements.

Element	Flame colour
lithium	red
sodium	yellow-orange
potassium	pale purple
rubidium	purple

He does a flame test on each mineral.

These are his results.

Mineral	Flame colour
A	yellow-orange
B	purple
C	green

Write down what conclusions you can make about which elements each mineral contains and explain why there is not enough information to identify all of the elements in the minerals.

The quality of written communication will be assessed in your answer.

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..... **[6]**

[Total: 6]

3 The halogens have different colours and states at room temperature.

(a) Draw straight lines to connect each **element** to its correct **colour** and **state** at room temperature.

colour	element	state
grey	chlorine	solid
green	bromine	liquid
orange	iodine	gas

[3]

(b) This is the symbol for fluorine on the Periodic Table.

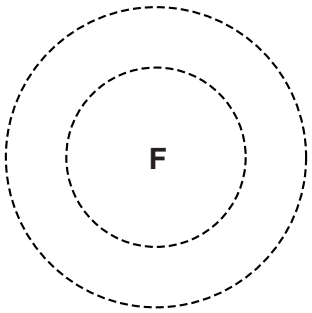
19
F
Fluorine
9

(i) Complete the sentence.

The nucleus of a fluorine atom contains 9 protons and 10 ..... **[1]**

(ii) The diagram shows part of the structure of a fluorine atom.

Complete the diagram to show the arrangement of electrons.
Use **x** to represent each electron.



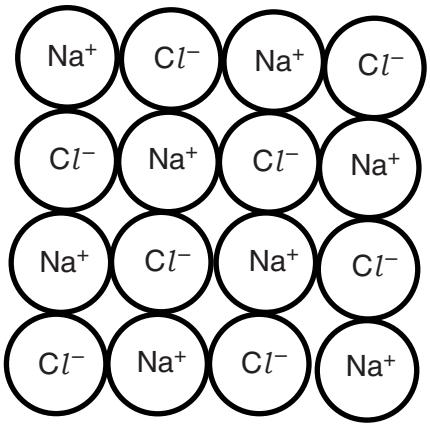
[2]

[Total: 6]

4 The chemical name for common salt is sodium chloride.

(a) The information shows the properties and arrangement of particles in solid salt and in salt solution.

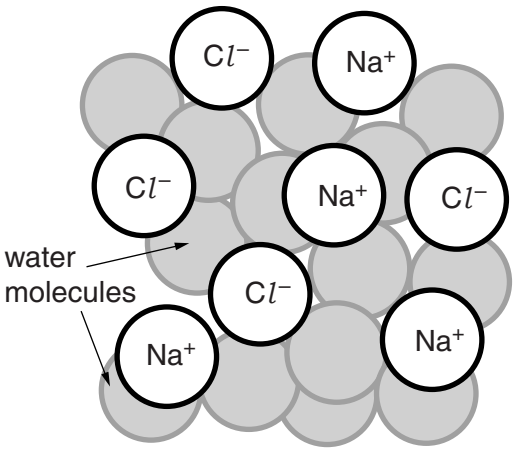
Solid salt



Properties

- hard solid
- very high melting point and boiling point
- does not conduct electricity

Salt solution



Properties

- solution has a melting point below room temperature
- conducts electricity

Explain how the properties of solid salt and salt solution depend on the arrangement and movement of their particles.

The quality of written communication will be assessed in your answer.

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..... **[6]**

(b) Salt is put on roads in winter because it lowers the freezing point of water.

Liz does some experiments to investigate whether salt can be used to stop water from freezing in extreme weather conditions.

She adds different masses of salt to 100 cm^3 of water and records the temperature when the water freezes.
Here are her results.

Mass of salt added to 100 cm^3 water in g	**Freezing point in °C**
0.0	0
5.0	–3
10.0	–6
15.0	–9

Liz talks about her results.

My data shows that there is a relationship between the freezing point and the mass of salt added.

I can use this data to predict the freezing point of water when higher masses of salt are added.

Liz

(i) What is the relationship shown in this data between the mass of salt added and the freezing point?

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..... **[2]**

(ii) Use the relationship to predict the freezing point when 25.0 g of salt are added.

Show your working.

Freezing point = ... °C **[2]**

(c) Liz does another experiment using 35.0 g of salt.

The table shows her results

Mass of salt added to 100 cm^3 water in g	Freezing point in °C
35.0	–6

(i) Liz thinks that this result may be an outlier.
Explain why she thinks this.

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..... **[1]**

(ii) What should Liz do to check whether this result is an outlier?

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..... **[1]**

(iii) Liz wants to investigate the relationship between mass of salt and the freezing point of water when she adds up to 50.0 g of salt.

Describe what experiments she should do.

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..... **[3]**

[Total: 15]

5 The table gives some information about three substances that are extracted from the Earth.

Substance	Where found	Solubility in water	Melting and boiling point
graphite	rocks	does not dissolve	very high
oxygen	atmosphere	low solubility	below room temperature
potassium chloride	sea	very soluble	very high

(a) Oxygen is found in the atmosphere. Potassium chloride is found in the sea.
Use the information to explain why oxygen and potassium chloride are not found in surface rocks.

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..... **[2]**

(b) Complete the table to show the missing **formulae** and **elements** in each substance.

Substance	Formula	Elements in substance
graphite		carbon only
oxygen		oxygen only
potassium chloride	KC*l*	

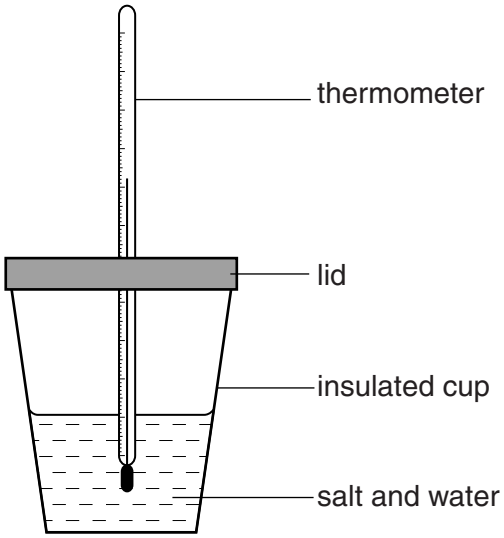
[2]

[Total: 4]

6 Rose investigates the energy changes when three salts dissolve in water.

She adds the same amount of each salt to the same amount of water.

She measures the maximum temperature change when each salt dissolves.

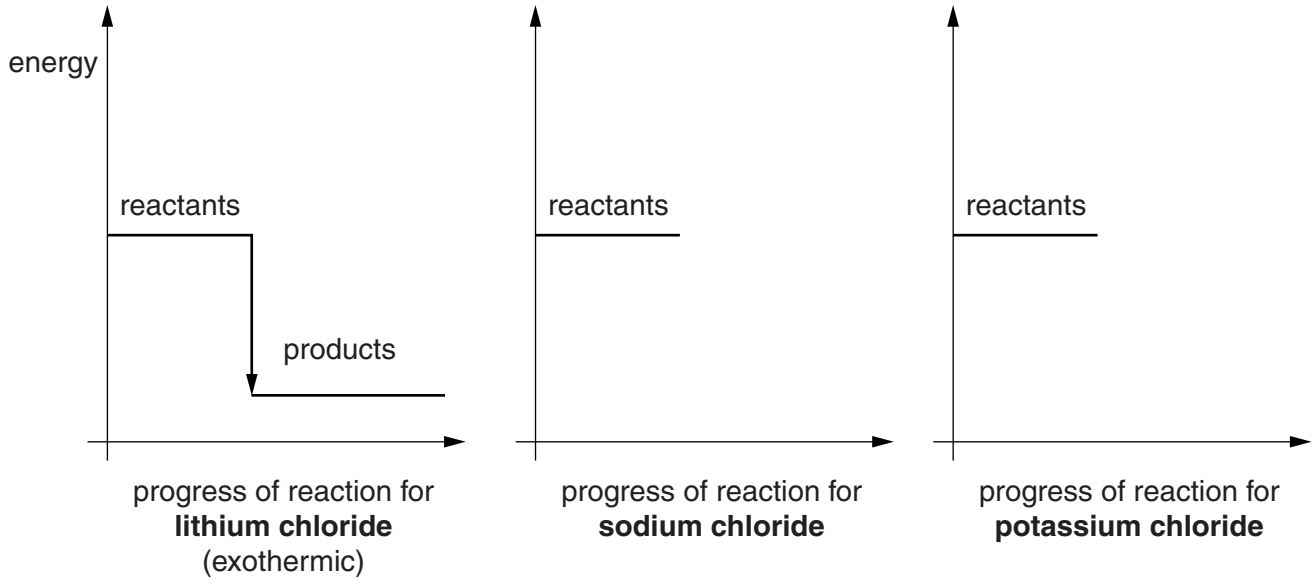


The table shows her results.

Salt	Temperature change in °C	Type of energy change
lithium chloride	+7.0	exothermic
sodium chloride	–0.5	endothermic
potassium chloride	–4.0	endothermic

13

Complete and label the energy level diagrams. Compare the changes in temperature and energy that happen when each salt dissolves.



progress of reaction for **lithium chloride** (exothermic)

progress of reaction for **sodium chloride**

progress of reaction for **potassium chloride**

The quality of written communication will be assessed in your answer.

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..... **[6]**

[Total: 6]

7 Matt finds out about the bonding in some compounds.
He dissolves them in water and uses a pH meter to find out if each compound is an acid or an alkali.

The table shows his results.

Compound	Bonding in compound	Acid or alkali?
sodium hydroxide	ionic	alkali
ammonia	covalent	alkali
hydrogen chloride	covalent	acid
ethanoic acid	covalent	acid
calcium hydroxide	ionic	alkali

(a) How does a pH meter show whether each compound is an acid or an alkali?

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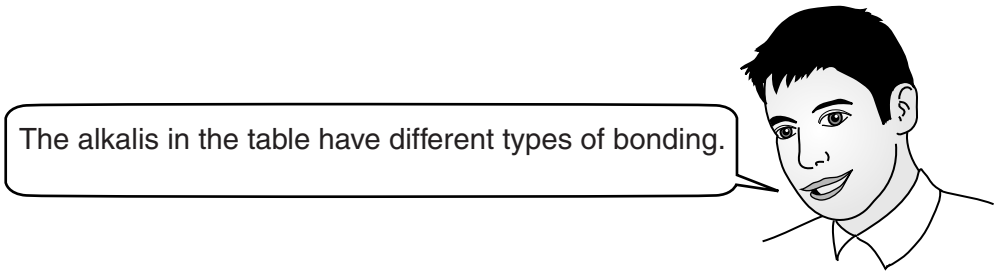
(b) Matt has an idea.



Do you agree with Matt's idea?
Use examples from the table to explain your reasoning.

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..... **[2]**

(c) The pure compounds in the table have different states at room temperature and pressure.

They all dissolve in water to form a solution.

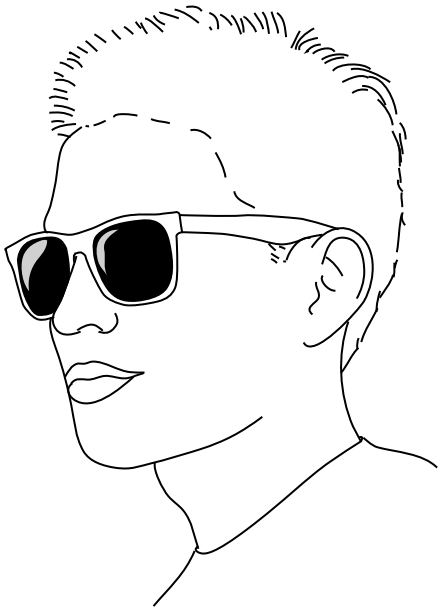
Draw straight lines to connect each **substance** to the correct **state symbol**.

substance	state symbol
solid sodium hydroxide	**(g)**
hydrogen chloride gas	**(l)**
liquid ethanoic acid	**(s)**
a solution dissolved in water	**(aq)**

[2]

[Total: 6]

8 Silver chloride is a salt that is used to make lenses that darken in bright light.



(a) Terry uses silver nitrate to make some silver chloride in a precipitation reaction.

This is the symbol equation for the reaction.

$$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$$

Use these words to write a word equation for this reaction.

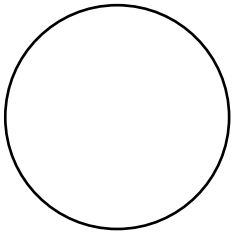
sodium chloride
silver chloride
sodium nitrate
silver nitrate

[2]

(b) In the reaction, silver chloride forms as a precipitate.

Terry wants to make a pure, dry sample of silver chloride from the reaction mixture.

The diagram shows the apparatus he uses.



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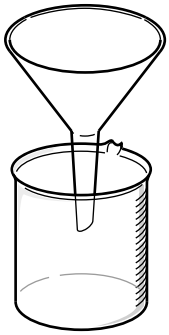

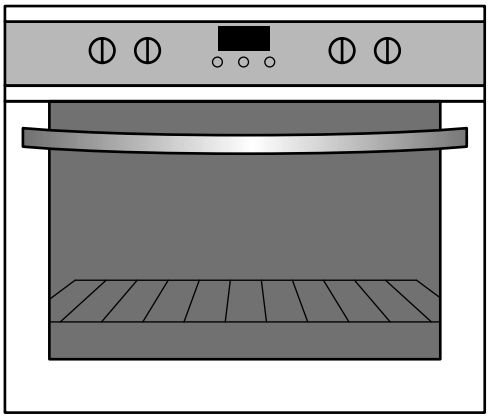

oven

Describe how Terry should use this apparatus to make a pure, dry sample of silver chloride.

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..... **[3]**

(c) The lenses go dark because a solid forms when light shines on silver chloride.

The solid is silver metal.

What is the name of the other element that forms in the reaction?

Put a (ring) around the correct answer.

carbon **chlorine** **hydrogen** **iodine** **water** **[1]**

[Total: 6]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.